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Effects of Increasing Crystalline Amino Acids in Sorghum- or Corn-based Diets on Finishing Pig Growth Performance and Carcass Composition

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Effects of Increasing Crystalline Amino Acids in Sorghum- or Corn-based Diets on Finishing Pig Growth Performance and Carcass Composition

Abstract

A study was conducted to determine the impact of increasing crystalline amino acids in either sorghum- or corn-based diets on finishing pig growth and carcass composition. A total of 288 pigs (PIC 327×1050; initially 101.1 lb) were used in a 90-d study with 8 pigs per pen and 6 pens per treatment. Treatments were arranged in a 2 × 3 factorial with main effects of grain source (sorghum vs. corn) and crystalline AA supplementation (low, medium, or high). Amino acids ratios to Lys as well as standardized ileal digestibility coefficients used were set by NRC (2012). All diets were formulated to the same Lys:NE ratio and at 95% of the pig's estimated Lys requirement to ensure that AA were not above the pigs' requirement. The grain sources and soybean meal were analyzed for AA profile and diets formulated from these concentrations. The low AA fortification contained L-lysine HCl and DL-methionine. The medium AA fortification contained L-lysine HCl, DL-methionine, and L-threonine. The high AA fortification contained L-lysine HCl, DL-methionine, L-threonine, and L-valine in sorghumor L-tryptophan in corn-based diets. Overall, there were no grain source × crystalline AA level interactions observed for any response criteria measured. Pigs fed corn-based diets tended to have greater ADG ($P < 0.072$) and had better F/G ($P < 0.01$) than those fed sorghum-based diets. As crystalline AA increased, ADG tended to increase then decrease (quadratic; $P=0.057$), and ADFI decreased (linear; $P = 0.019$) resulting in a tendency for improved F/G (quadratic; $P=0.097$). Pigs fed sorghum had decreased ($P < 0.01$) jowl fat iodine value in comparison to those fed corn-based diets. Crystalline AA level did not impact carcass characteristics. In conclusion, diets with high AA fortification had decreased ADG and ADFI with slightly improved F/G compared with low or medium AA fortification. Furthermore, grain sorghum had approximately 97% of the feeding value relative to corn based on F/G.

Keywords

corn, crystalline AA, finishing pig, sorghum

Cover Page Footnote

Appreciation is expressed to the United States Sorghum Check-off Council, Lubbock, TX for partial financial support of this study as well as Ajinomoto Heartland, Chicago, IL for amino acid analysis.

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Effects of Increasing Crystalline Amino Acids in Sorghum- or Corn-based Diets on Finishing Pig Growth Performance and Carcass Composition[1]

K. E. Jordan, R. D. Goodband, J. C. Woodworth, M. D. Tokach, S. S. Dritz[2], and J. M. DeRouchey

Summary

A study was conducted to determine the impact of increasing crystalline amino acids in either sorghum- or corn-based diets on finishing pig growth and carcass composition. A total of 288 pigs (PIC 327×1050; initially 101.1 lb) were used in a 90-d study with 8 pigs per pen and 6 pens per treatment. Treatments were arranged in a 2 × 3 factorial with main effects of grain source (sorghum vs. corn) and crystalline AA supplementation (low, medium, or high). Amino acids ratios to Lys as well as standardized ileal digestibility coefficients used were set by NRC (2012)[3]. All diets were formulated to the same Lys:NE ratio and at 95% of the pig's estimated Lys requirement to ensure that AA were not above the pigs' requirement. The grain sources and soybean meal were analyzed for AA profile and diets formulated from these concentrations. The low AA fortification contained L-lysine HCl and DL-methionine. The medium AA fortification contained L-lysine HCl, DL-methionine, and L-threonine. The high AA fortification contained L-lysine HCl, DL-methionine, L-threonine, and L-valine in sorghum- or L-tryptophan in corn-based diets. Overall, there were no grain source × crystalline AA level interactions observed for any response criteria measured. Pigs fed corn-based diets tended to have greater ADG ($P < 0.072$) and had better F/G ($P < 0.01$) than those fed sorghum-based diets. As crystalline AA increased, ADG tended to increase then decrease (quadratic; P=0.057), and ADFI decreased (linear; $P = 0.019$) resulting in a tendency for improved F/G (quadratic; P=0.097). Pigs fed sorghum had decreased ($P < 0.01$) jowl fat iodine value in comparison to those fed corn-based diets. Crystalline AA level did not impact carcass characteristics. In conclusion, diets with high AA fortification had decreased ADG and ADFI with slightly improved F/G compared with low or medium AA fortification. Furthermore, grain sorghum had approximately 97% of the feeding value relative to corn based on F/G.

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[1] Appreciation is expressed to the United States Sorghum Check-off Council, Lubbock, TX for partial financial support of this study as well as Ajinomoto Heartland, Chicago, IL for amino acid analysis.

[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

[3] NRC. 2012. Nutrient Requirements of Swine. 11th rev. ed. Natl. Acad. Press, Washington, D.C.

Key words: corn, crystalline AA, finishing pig, sorghum

Introduction

In order to lower feed costs, crystalline AA are used routinely in swine diets to replace a portion of the soybean meal. The AA that are currently available to add to swine diets include lysine, threonine, methionine, tryptophan, and valine. The increased availability of crystalline AA sources has created the opportunity to formulate grain-based diets to the fifth or sixth limiting AA. If this can be accomplished without negatively affecting pig growth performance, it should result in greater economic return. Because AA requirement estimates are now routinely based on standardized ileal digestible (SID) AA ratios relative to Lys, the objective of this experiment was to determine the effects of feeding increasing concentrations of crystalline AA as a replacement for soybean meal in sorghum- or corn-based diets on growth performance and carcass composition of finishing pigs.

Materials and Methods

The Kansas State University Institutional Animal Care and Use Committee approved the experimental procedures and animal care for this study. This experiment was conducted in the finishing facility at the Kansas State University Swine Teaching and Research Center in Manhattan, KS. The facility is a totally enclosed, environmentally controlled, mechanically ventilated barn. Each pen contained a 2-hole, dry self-feeder and a cup waterer to provide ad libitum access to feed and water. Pens (5 × 10 ft) were located over a completely slatted concrete floor.

A total of 288 pigs (PIC 327×1050; initially 101.1 lb) were used in a 90-d study with 8 pigs per pen and 6 pens per treatment. Treatments were arranged in a 2 × 3 factorial with main effects of grain source (sorghum vs. corn) and crystalline AA supplementation (low, medium, or high). The grain sources and soybean meal were analyzed for AA profile and diets formulated from these concentrations (Table 1). Amino acids ratios to Lys as well as standardized ileal digestibility coefficients used were set by NRC (2012). All diets (Tables 2 to 5) were fed in meal form in 4 phases and formulated to the same Lys:NE ratio and at 95% of the pig's estimated Lys requirement to ensure that AA were not above the pigs' requirement. The low AA fortification contained L-lysine HCl and DL-methionine. The medium AA fortification contained L-lysine HCl, DL-methionine and L-threonine. The high AA fortification contained L-lysine HCl, DL-methionine, L-threonine, and L-valine in sorghum- or L-tryptophan in corn-based diets.

Pig weight and feed disappearance were measured approximately every 2 wk to determine ADG, ADFI, and F/G. On d 90, all pigs were individually weighed and tattooed for carcass data collection and transported 130 mi. to a commercial packing plant (Triumph Foods LLC, St. Joseph, MO) for collection of standard carcass data and jowl fat iodine value (IV). Jowl fat IV was calculated using near infrared spectroscopy (NIR; Bruker MPA; Multi-Purpose Analyzer). Hot carcass weights were measured immediately after evisceration and each carcass was evaluated for percentage carcass yield, backfat, loin depth, and percentage lean. Fat depth and loin depth were measured with an optical probe inserted approximately 3 in. from the dorsal midline between the 3rd and 4th last rib (counting from the ham end of the carcass). Percentage carcass yield was calculated by dividing HCW at the plant by live weight at the farm.

Feed samples for each dietary treatment were taken at multiple times during the experiment, and sub-sampled for chemical analysis. Feed samples were analyzed for DM, Ca, and P (Ward Laboratories, Inc., Kearney, NE) and for total AA and CP (Ajinomoto Heartland, Inc., Chicago, IL).

Data were analyzed as a randomized complete block design using PROC MIXED in SAS (SAS Institute, Inc., Cary, NC) with pen as the experimental unit. Data were analyzed as a 2 × 3 factorial with interactive and main effects of grain source and AA fortification. In addition, the data were analyzed for linear and quadratic effects of increasing AA concentrations. Results from the experiment were considered significant at $P \leq 0.05$ and a tendency between $P > 0.05$ and ≤ 0.10.

Results and Discussion

Results of diet analysis were similar to formulated values (Tables 6 and 7). Overall, no grain source × crystalline AA interactions were observed (Table 8). Pigs fed corn-based diets tended to have greater ADG ($P < 0.072$) and had better F/G ($P < 0.01$) than those fed sorghum-based diets. As crystalline AA concentrations increased, ADG tended to increase then decrease (quadratic; $P = 0.057$), ADFI decreased (linear; $P = 0.019$), and F/G tended to improve to the medium AA fortification level and then became poorer at the highest AA fortification (quadratic; $P = 0.097$). Pigs fed corn-based diets tended to have greater loin depth ($P = 0.088$) and increased ($P < 0.01$) jowl fat IV compared to pigs fed sorghum-based diets. Increasing crystalline AA fortification did not influence any carcass characteristic.

In conclusion, these data suggest corn-based diets will improve performance compared to sorghum-based diets with the feeding value of sorghum being 97% compared to corn, based on F/G. At the high addition of crystalline AA, ADG, but not F/G worsened, suggesting these diets were deficient in a different AA or nutrient needed to support maximum growth performance. Additional research should be conducted to determine proper diet formulation strategies needed to maximize growth performance of pigs when high levels of crystalline AA are included in the diets.

Table 1. Analyzed AA concentration of sorghum, corn, and soybean meal (%, as-fed basis)[1]

Amino acid, %	Sorghum	Corn	Soybean meal
Arginine	0.29	0.36	3.33
Histidine	0.16	0.23	1.19
Isoleucine	0.26	0.28	2.12
Leucine	0.82	0.98	3.47
Lysine	0.17	0.23	2.86
Methionine	0.13	0.17	0.65
Phenylalanine	0.34	0.37	2.33
Threonine	0.23	0.28	1.82
Tryptophan	0.08	0.06	0.68
Valine	0.33	0.36	2.13

[1] Values represent the mean of three samples analyzed in duplicate by Ajinomoto Heartland, Inc., Chicago, IL.

Table 2. Phase 1 diet composition (as-fed basis)[1]

	Sorghum			Corn		
Item	Low	Medium	High	Low	Medium	High
Ingredient, %						
Corn	--	--	--	74.25	77.80	83.75
Sorghum	73.71	78.86	79.91	--	--	--
Soybean meal (46.5% CP)	23.65	18.16	17.01	23.05	19.29	13.75
Monocalcium phosphate (21% P)	0.75	0.80	0.82	0.82	0.84	0.51
Limestone	1.03	1.00	1.00	1.07	1.04	1.00
Salt	0.35	0.35	0.35	0.35	0.35	0.15
L-Lysine-HCL	0.15	0.33	0.37	0.16	0.29	0.36
DL-methionine	0.04	0.10	0.12	--	0.04	0.05
L-threonine	--	0.09	0.10	--	0.05	0.08
L-tryptophan	--	--	--	--	--	0.01
L-valine	--	--	0.02	--	--	--
Vitamin premix	0.15	0.15	0.15	0.15	0.15	0.15
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15
Phytase[2]	0.02	0.02	0.02	0.02	0.02	0.02
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis						
SID lys:NE, g/Mcal	3.64	3.64	3.64	3.64	3.64	3.64
Standardized ileal digestible (SID) AA, %						
Lys	0.81	0.82	0.83	0.84	0.85	0.85
Ile:lys	73.3	61.1	58.5	72.1	64.0	59.7
Leu:lys	151	133	129	159	148	142
Met:lys	31.6	35.1	35.8	29.0	31.2	32.4
Met & cys:lys	56.7	56.7	56.7	56.7	56.7	56.7
Thr:lys	61	61	61	62	61	61
Trp:lys	23.4	19.3	18.5	21.2	18.5	18.5
Val:lys	77.0	65.2	65.2	76.9	69.2	65.2
Total lys, %	0.92	0.91	0.91	0.96	0.96	0.96
NE NRC, kcal/lb	1,085	1,098	1,100	1,120	1,131	1,137
CP, %	17.3	15.2	14.8	17.7	16.3	15.6
Ca, %	0.61	0.59	0.59	0.62	0.60	0.60
P, %	0.50	0.49	0.48	0.51	0.50	0.49
Available P, %	0.34	0.34	0.34	0.34	0.34	0.34

[1] Experimental diets were fed for 20 d from 101 to 145 lb.
[2] Ronozyme HiPhos (GT) 2700 (DSM Nutritional Products, Parsippany, NJ) provided 476.28 phytase units (FTU)/kg with a release of 0.10% available P.

Table 3. Phase 2 diet composition (as-fed basis)[1]

	Sorghum			Corn		
Item	Low	Medium	High	Low	Medium	High
Ingredient, %						
Corn	--	--	--	79.15	81.95	83.75
Sorghum	77.26	82.67	84.06	--	--	--
Soybean meal (46.5% CP)	20.55	14.75	13.20	18.53	15.51	13.75
Monocalcium phosphate (21% P)	0.34	0.38	0.42	0.45	0.48	0.51
Limestone	1.00	1.03	1.03	1.00	1.00	1.00
Salt	0.35	0.35	0.35	0.35	0.35	0.15
L-Lysine-HCL	0.15	0.34	0.39	0.20	0.30	0.36
DL-methionine	0.03	0.09	0.11	--	0.03	0.05
L-threonine	--	0.09	0.11	0.01	0.06	0.08
L-tryptophan	--	--	--	--	--	0.01
L-Valine	--	--	0.03	--	--	--
Vitamin premix	0.15	0.15	0.15	0.15	0.15	0.15
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15
Phytase[2]	0.02	0.02	0.02	0.02	0.02	0.02
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis						
SID lys:NE, g/Mcal	3.22	3.22	3.22	3.22	3.22	3.22
Standardized ileal digestible (SID) AA, %						
Lys	0.74	0.75	0.75	0.76	0.77	0.78
Ile:lys	73.9	59.7	56.1	69.6	62.5	58.2
Leu:lys	156.5	135.7	130.5	162.4	152.3	146.1
Met:lys	30.8	35.0	36.0	28.8	30.7	31.8
Met & cys:lys	56.6	56.7	56.6	56.8	56.6	56.6
Thr:lys	61.2	61.2	61.2	61.2	61.2	61.2
Trp:lys	23.5	18.8	17.6	20.0	17.6	17.6
Val:lys	78.3	64.7	64.7	75.5	68.8	64.7
Total lys, %	0.84	0.83	0.83	0.87	0.87	0.87
NE NRC, kcal/lb	1096	1109	1113	1138	1146	1153
CP, %	16.0	13.8	13.3	15.9	14.8	14.2
Ca, %	0.52	0.52	0.52	0.52	0.52	0.52
P, %	0.40	0.38	0.38	0.41	0.41	0.41
Available P, %	0.25	0.25	0.26	0.25	0.26	0.26

[1] Experimental diets were fed for 22 d from 145 to 190 lb.
[2] Ronozyme HiPhos (GT) 2700 (DSM Nutritional Products, Parsippany, NJ) provided 476.28 phytase units (FTU)/kg with a release of 0.10% available P.

Table 4. Phase 3 diet composition (as-fed basis)[1]

	Sorghum			Corn		
Item	Low	Medium	High	Low	Medium	High
Ingredient, %						
Corn	--	--	--	83.25	84.35	83.75
Sorghum	79.88	85.45	86.43	--	--	--
Soybean meal (46.5% CP)	18.21	12.22	11.12	14.61	13.42	13.75
Monocalcium phosphate (21% P)	0.20	0.25	0.28	0.34	0.35	0.51
Limestone	0.90	0.93	0.93	0.88	0.90	1.00
Salt	0.35	0.35	0.35	0.35	0.35	0.15
L-Lysine-HCL	0.13	0.32	0.36	0.23	0.27	0.36
DL-methionine	0.02	0.08	0.09	--	0.01	0.05
L-threonine	--	0.09	0.11	0.03	0.05	0.08
L-tryptophan	--	--	--	--	--	0.01
L-valine	--	--	0.02	--	--	--
Vitamin premix	0.15	0.15	0.15	0.15	0.15	0.15
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15
Phytase[2]	0.02	0.02	0.02	0.02	0.02	0.02
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis						
SID lys:NE, g/Mcal	2.88	2.88	2.88	2.88	2.88	2.88
Standardized ileal digestible (SID) AA, %						
Lys	0.67	0.67	0.68	0.70	0.70	0.70
Ile:lys	76	60	57	67	64	58
Leu:lys	165	142	137	166	162	154
Met:lys	31	35	36	29	30	32
Met & cys:lys	57.5	57.5	57.5	57.5	57.5	57.5
Thr:lys	63.0	63.0	63.0	63.0	63.0	63.0
Trp:lys	24.0	18.7	17.8	18.8	17.8	17.8
Val:lys	81.2	65.8	65.8	74.3	71.6	65.8
Total lys, %	0.76	0.75	0.75	0.79	0.79	0.79
NE NRC, kcal/lb	1104	1117	1119	1151	1154	1161
CP, %	15.0	12.8	12.4	14.4	13.9	13.1
Ca, %	0.45	0.45	0.45	0.45	0.45	0.45
P, %	0.36	0.34	0.34	0.37	0.37	0.36
Available P, %	0.22	0.22	0.22	0.23	0.23	0.22

[1] Experimental diets were fed for 21 d from 190 to 230 lb.
[2] Ronozyme HiPhos (GT) 2700 (DSM Nutritional Products, Parsippany, NJ) provided 476.28 phytase units (FTU)/kg with a release of 0.10% available P.

Table 5. Phase 4 diet composition (as-fed basis)[1]

	Sorghum			Corn		
Item	Low	Medium	High	Low	Medium	High
Ingredient, %						
Corn	--	--	--	86.55	87.05	89.30
Sorghum	82.27	88.07	88.69	--	--	--
Soybean meal (46.5% CP)	16.06	9.81	9.13	11.47	10.95	8.48
Monocalcium phosphate (21% P)	0.05	0.12	0.15	0.20	0.20	0.25
Limestone	0.85	0.87	0.85	0.85	0.85	0.85
Salt	0.35	0.35	0.35	0.35	0.35	0.35
L-Lysine-HCL	0.11	0.31	0.33	0.23	0.25	0.33
DL-methionine	0.004	0.07	0.08	--	--	0.02
L-threonine	--	0.09	0.10	0.04	0.05	0.09
L-tryptophan	--	--	--	--	0.004	0.02
L-valine	--	--	0.01	--	--	--
Vitamin premix	0.15	0.15	0.15	0.15	0.15	0.15
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15
Phytase[2]	0.02	0.02	0.02	0.02	0.02	0.02
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis						
SID lys:NE, g/Mcal	2.56	2.56	2.56	2.56	2.56	2.56
Standardized ileal digestible (SID) AA, %						
Lys	0.60	0.60	0.60	0.62	0.62	0.63
Ile:lys	79.0	60.4	58.4	66.7	65.2	58.3
Leu:lys	176.5	149.2	146.3	174.9	172.8	162.9
Met:lys	30.7	36.0	36.6	30.4	30.0	31.8
Met & cys:lys	59.0	59.0	59.0	59.9	59.0	59.0
Thr:lys	65.6	65.6	65.6	65.6	65.6	65.6
Trp:lys	24.9	18.7	18.1	18.1	18.1	18.1
Val:lys	85.1	67.3	67.2	75.2	73.8	67.2
Total lys, %	0.68	0.67	0.67	0.71	0.71	0.71
NE NRC, kcal/lb	1110	1124	1126	1161	1163	1170
CP, %	14.1	11.8	11.6	13.1	12.9	12.1
Ca, %	0.40	0.40	0.40	0.40	0.40	0.40
P, %	0.32	0.30	0.31	0.33	0.33	0.33
Available P, %	0.18	0.19	0.19	0.19	0.19	0.20

[1] Experimental diets were fed for 27 d from 230 to 282 lb.
[2] Ronozyme HiPhos (GT) 2700 (DSM Nutritional Products, Parsippany, NJ) provided 478.26 phytase units (FTU)/kg with a release of 0.10% available P.

Table 6. Chemical analysis of experimental diets Phase 1 and 2 (as-fed basis)[1]

	Grain source[2]						Grain source[3]					
	Sorghum			Corn			Sorghum			Corn		
	Crystalline AA			Crystalline AA			Crystalline AA			Crystalline AA		
Item	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
DM, %	86.79	86.68	86.52	87.22	87.20	86.75	86.46	86.40	86.43	86.60	86.83	86.51
CP, %	17.3	15.4	14.7	17.7	16.6	16.2	16.8	13.4	13.0	16.2	15.0	14.5
Ca, %	0.84	0.73	0.56	0.66	0.60	0.57	0.71	0.85	0.63	0.62	0.58	0.71
P, %	0.47	0.43	0.45	0.57	0.59	0.51	0.43	0.36	0.34	0.43	0.45	0.42
Amino acids, %												
Arg	1.05	0.87	0.84	1.12	0.98	0.93	0.99	0.73	0.65	0.92	0.85	0.80
His	0.42	0.36	0.35	0.46	0.41	0.40	0.40	0.31	0.28	0.40	0.38	0.36
Ile	0.77	0.67	0.69	0.72	0.68	0.62	0.68	0.54	0.48	0.62	0.58	0.55
Leu	1.57	1.42	1.36	1.62	1.52	1.48	1.47	1.28	1.18	1.46	1.42	1.38
Lys	0.98	0.94	0.97	1.01	0.98	0.96	0.91	0.82	0.79	0.90	0.85	0.90
Met	0.30	0.32	0.34	0.30	0.30	0.30	0.28	0.28	0.29	0.28	0.27	0.28
Thr	0.64	0.65	0.60	0.68	0.67	0.69	0.61	0.55	0.54	0.58	0.57	0.60
Trp	0.20	0.18	0.17	0.20	0.17	0.17	0.20	0.17	0.15	0.17	0.16	0.16
Val	0.83	0.73	0.72	0.82	0.76	0.70	0.75	0.61	0.60	0.69	0.65	0.63

[1] Multiple samples were collected from each diet throughout the study, homogenized, and then subsampled for analysis at Ward Laboratories, Kearney, NE and Ajinomoto Heartland, Inc., Chicago, IL.
[2] Analyzed values for Phase 1 finishing pig diets.
[3] Analyzed values for Phase 2 finishing pig diets.

Table 7. Chemical analysis of experimental diets Phase 3 and 4 (as-fed basis)[1]

	Grain source[2]						Grain source[3]					
	Sorghum			Corn			Sorghum			Corn		
	Crystalline AA			Crystalline AA			Crystalline AA			Crystalline AA		
Item	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
DM, %	87.31	86.63	86.72	85.76	86.26	86.24	86.76	86.59	86.44	86.89	86.54	86.94
CP, %	15.5	12.2	12.0	15.0	13.7	13.2	14.1	12.0	11.6	13.5	13.0	11.9
Ca, %	0.60	0.70	0.55	0.43	0.57	0.55	0.52	0.52	0.49	0.48	0.41	0.58
P, %	0.47	0.36	0.32	0.45	0.42	0.39	0.32	0.33	0.3	0.31	0.31	0.36
Amino acids, %												
Arg	0.95	0.65	0.61	0.87	0.80	0.69	0.79	0.61	0.56	0.73	0.70	0.62
His	0.38	0.29	0.28	0.39	0.36	0.32	0.33	0.27	0.26	0.34	0.33	0.34
Ile	0.64	0.49	0.48	0.59	0.54	0.48	0.56	0.49	0.43	0.50	0.52	0.47
Leu	1.39	1.20	1.18	1.45	1.35	1.27	1.27	1.11	1.09	1.32	1.32	1.23
Lys	0.84	0.73	0.72	0.82	0.82	0.76	0.71	0.68	0.65	0.71	0.72	0.72
Met	0.26	0.26	0.27	0.26	0.25	0.25	0.23	0.24	0.25	0.23	0.22	0.23
Thr	0.58	0.47	0.49	0.56	0.56	0.51	0.51	0.50	0.45	0.50	0.48	0.48
Trp	0.20	0.15	0.14	0.15	0.14	0.13	0.17	0.13	0.13	0.13	0.12	0.12
Val	0.72	0.56	0.56	0.68	0.62	0.57	0.63	0.58	0.52	0.59	0.63	0.55

[1] Multiple samples were collected from each diet throughout the study, homogenized, and then subsampled for analysis at Ward Laboratories, Kearney, NE and Ajinomoto Heartland, Inc., Chicago, IL.
[2] Analyzed values for Phase 3 finishing pig diets.
[3] Analyzed values for Phase 4 finishing pig diets.

Table 8. Interactive effects of grain source and crystalline AA level on growth performance and carcass characteristics of finishing pigs[1]

	Grain source							Probability, $P <$ [3]		
	Sorghum			Corn						
	Crystalline AA[2]			Crystalline AA				Grain	Crystalline AA	
Item	Low	Medium	High	Low	Medium	High	SEM	source	Linear	Quadratic
d 0 to 90										
ADG, lb	1.99	2.00	1.93	2.02	2.05	1.98	0.028	0.072	0.055	0.057
ADFI, lb	5.86	5.78	5.62	5.78	5.80	5.60	0.082	0.696	0.019	0.289
F/G	2.94	2.89	2.92	2.86	2.83	2.84	0.021	0.001	0.290	0.097
BW, lb										
d 0	101.2	101.2	101.2	100.9	101.1	101.0	1.62	0.891	0.967	0.972
d 90	280.3	281.6	274.4	282.9	285.4	278.8	3.51	0.218	0.167	0.162
Carcass characteristics										
HCW, lb	204.3	205.0	203.6	206.7	206.7	203.7	2.48	0.486	0.454	0.454
Carcass yield, %[4]	73.2	73.0	73.3	73.3	73.0	73.2	0.01	1.000	1.000	1.000
Loin depth, mm	57.8	58.9	58.1	60.9	60.4	57.8	1.00	0.088	0.166	0.166
BF, mm	19.3	19.6	19.9	19.5	19.0	20.6	0.86	0.869	0.318	0.318
FFLI, %[5]	52.2	52.3	52.2	52.5	52.8	52.0	0.01	0.583	0.614	0.614
Jowl iodine value	67.9	67.9	67.3	68.8	68.9	69.6	0.59	0.006	0.875	0.875

[1] A total of 288 pigs (PIC 1050) were used with 8 pigs per pen and 6 pens per treatment.
[2] The low AA fortification contained L-lys HCl and DL-met. The medium AA fortification contained L-lys HCl, DL-met, and L-thr, and the high AA fortification contained L-lys HCl, DL-met, L-thr, and L-trp or L-val.
[3] No grain source × AA level interactions were observed ($P > 0.10$).
[4] Percentage carcass yield was calculated by dividing HCW by live weight before transport to the packing plant (Triumph Foods, LLC., St Joseph, MO).
[5] Fat-free lean index.